Impact of time of day of harvest on nitrate concentration in forage sorghums

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STORY IN BRIEF

Forage sorghums are used by cattle producers for summer grazing or harvested for hay. Forage sorghums can be very productive and high quality, but can also accumulate toxic levels of nitrate when stressed. Based on the assumption that the plant continues soil nitrate uptake during nighttime hours, followed by accelerated conversion of the nitrate to protein during daylight hours, extension recommendations have been to wait until afternoon to cut forage sorghum for hay if anticipated nitrate levels are marginally high. To evaluate the significance of the change in nitrate concentration in forage sorghums during the day, samples were collected at two hour intervals from 8:00 AM to 6:00 PM. Five cooperator's fields ("farm") were divided into quadrants. Three random samples, consisting of ten stems each, were taken from each quadrant at the specified interval. The samples were analyzed at the Oklahoma State University Soil, Water, and Forage Analytical Laboratory to determine the level of nitrates, (ppm NO_3). As expected, "farm" was a significant source of variation for both mean nitrate concentration. There was no significant time of day, or time of day x farm interaction for mean nitrate concentrations ($p=.20$; $p>0.71$, respectively). The mean nitrate concentrations across all farms only varied from 3857 ppm at 8:00 AM to 4962 ppm at 12 noon. Time of day of harvest did not impact nitrate concentration or proportion of dangerous samples of forage sorghum hay.

Key Words: nitrate, time of day, forage sorghum

INTRODUCTION

Farmers and ranchers across the Oklahoma often depend on the production and utilization of forage sorghums for cattle grazing and hay production. Forage sorghums can be successfully produced, but must be monitored for high levels of nitrates that can occasionally be toxic to ruminants. Western Oklahoma will experience hot, dry, stressful growing conditions in mid-summer when forage sorghums are growing. Any condition that disrupts plant metabolism will predispose the plant to nitrate accumulation.

When nitrate is ingested by cattle, it undergoes a chemical reduction in the rumen to form nitrite. Nitrite is readily absorbed into the bloodstream, where it converts hemoglobin to methemoglobin. This greatly reduces the oxygen carrying capacity of the blood. If severe enough, the animal suffers from oxygen starvation of the tissue (asphyxiation) resulting in death (Smith and Selk, 1993).

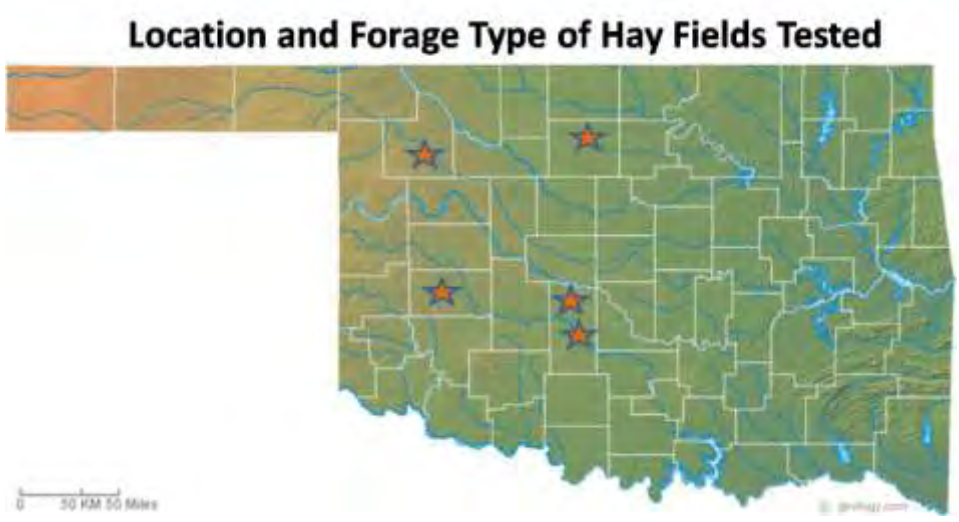
The effect of nitrate on livestock can be minimized if conditions for excessive nitrate accumulation are understood and appropriate management practices applied. Extension Educators have for years, placed an emphasis on educating producers about potential nitrate toxicity from forages, proper management practices, and forage testing to monitor nitrate levels in forage sorghums. Proper management of the crop offers increased potential for use as a feed resource.

Plant roots absorb soil nitrate. Under suitable growing conditions, nearly all nitrate is converted to amino acids and subsequently proteins. Based on the assumption that protein synthesis slows during night time, followed by an increase after a period of sunlight, the recommendation is made in many Extension publications to harvest or turn cattle onto forage sorghums in the afternoon, rather than early morning. Increased protein synthesis should lower the relative amount of nitrate in plant tissue as daylight hours accumulate. (Gill, D., 1969; Ruhr and Osweiler, 1986; Cash et al., 2007.)

A lack of data to support this recommendation led to a field trail in September, 2007 and the summer of 2008 to investigate the relationship of time of day and nitrate level in forage sorghum.

MATERIALS AND METHODS

Five locations were planted to forage sorghums with the timing and variety to be typical of the area. The five locations were on four privately-owned cooperator farms and one Oklahoma Agricultural Experiment Station site. The cooperators were located in Garfield, Grady, Washita, and Woodward Counties of Western Oklahoma. The Experiment station site was also in Grady County. The first site examined was the cooperator site in Grady County and sampling was done in September of 2007. This site was a second-cutting forage sorghum. The other four sites were tested in June, July, and September of 2008. Three fields had been planted with Sorghum/sudan hybrids, and one with a Sorgo/sudan hybrid. No site received more than 40 pounds/acre of actual nitrogen fertilizer. Sampling took place when the forage was judged to be at a stage of maturity similar to when producers would harvest for hay. Each site was divided into quadrants of approximately equal size. The first site in September, 2007 was sampled on two consecutive days. Two quadrants were sampled on each day. The other four sites were all sampled on a single day.



Farm 1: Grady County (near Amber) sampled on 9-17-07 – Forage Sorghum
Farm 2: Grady County (OSU research station) sampled on 6-24-08 – Sorghum/sudan

Farm 3: Woodward County sampled on 7-25-08 – Sorghum/sudan
Farm 4: Washita County sampled on 7-31-08 – Sorgo/sudan
Farm 5: Garfield County sampled on 9-23-08 –Sorghum/sudan

The forage was sampled every other hour beginning at 8:00 AM. Three random samples (each consisting of 10 stems) were taken at each designated sampling time, 8:00 AM, 10:00 AM, 12 noon, 2:00 PM, 4:00 PM, and 6:00 PM. There were a total of 18 samples per quadrant. Clipping height was consistent at about 4 inches to simulate cutting height under producer field harvesting conditions. The 10 stems representing each random sample were cut with a flower cutter into approximately 1 inch pieces and mixed. From this, a grab sample was taken and submitted to the Oklahoma State University Soil, Water, and Forage Analytical Laboratory for moisture content and nitrate analysis. Nitrate was determined using an acetic acid extraction with cadmium reduction analysis.

Results were analyzed using the PROC MIXED procedure of SAS, with time of day, farm, and interactions as sources of the variation in mean nitrate concentration.

RESULTS AND DISCUSSION

"Farm" was a significant ($P<.0001$) source of variation in the concentration of nitrates found in the samples. Farm number 1 (the field sampled in September of 2007) had greater ($P<.01$) concentration of nitrates than did any of the other farms (Table 1). No Farm X Time of Day interaction was noted ($P > .76$) which allowed for the comparison of time of day of harvest across all five farms. Farm 1 had significantly greater concentrations of nitrate in the forage than was found in the other farms. Likewise, Farm 3 had significantly lower concentrations of nitrate. This should be expected as environmental conditions such as temperature, rainfall, soil type, forage type, and fertilization have been shown to be contributing factors in the concentration of nitrate in the harvested forage.

Time of day did not have a significant impact on nitrate concentration ($P=.20$). Time of day of harvest did not impact nitrate concentration. There was no indication that nitrate concentration decreased throughout the day time hours as has been previously predicted. Therefore, harvesting of summer annual forage sorghums can be conducted at any time from 8:00 AM to 6:00 PM without affecting nitrate concentration of the harvested hay.

Table 1. Least Squares Means of Nitrate Concentrations (ppm) of Forage Sorghums on Five Farms at Different Harvest Times of the Day

	8:00AM	10:00AM	12 Noon	2:00 PM	4:00PM	6:00PM	Mean of All Times (by Farm): SE=341.5
Farm 1	8825	7421	11263	9102	9292	7708	8935
Farm 2	1712	1515	1776	1578	2017	1404	1667
Farm 3	406	406	493	362	365	439	412
Farm 4	3198	4665	5870	4889	5429	6030	5014
Farm 5	5145	4833	5407	4768	5694	4803	5108
Mean of All Farms (by Time): SE=374.1	3857	3768	4962	4140	4560	4077	4227

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